REMARKS

None of the claims have been amended with this response after final. A copy of the claims is provided above for the Examiner's convenience.

REJECTIONS

Claims 1-3, 5, 6, 11, 12, 13, 15, 16, 20, and 24 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Laroche et al. ("HNM: A Simple Efficient Harmonic and Noise Model for Speech" 1993, hereinafter Laroche) in view of Rao Gadde et al. (U.S. Patent No. 7,120,580, hereinafter Rao Gadde) in view of Gao (U.S. Patent Publication 2002/0035470) and in view of Rezayee ("An Adaptive KLT Approach for Speech Enhancement"). Claims 7-10, 17, and 25 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Laroche in view of Rao Gadde in view of Gao in view of Rezayee and in further view of Seltzer (CMU Speech Group 1999).

CLAIMS 1-3 AND 5-12

Claim 1 provides a method of identifying an estimate for a noise-reduced value representing a portion of a noise-reduced speech signal. The method includes decomposing each frame of a noisy speech signal into a harmonic component for the frame and a random component for the frame. For each frame, a separate scaling parameter is determine for at least the harmonic component, wherein determining a scaling parameter for each frame of a harmonic component comprises determining a ratio of an energy of the harmonic component in the frame without the random component of the frame to an energy of the frame of the noisy speech signal. For each frame, the harmonic component of the frame is multiplied by the scaling parameter of the frame for the harmonic component to form a scaled harmonic component for the frame. For each frame, the random component of the frame is multiplied by a fixed scaling parameter for the random component that is the same for all frames and that is less than 1. This forms a scaled random component for the frame. For each frame, the scaled harmonic component for the frame is summed with the scaled random component for the frame to form the noise-reduced value

representing a frame of a noise-reduced speech signal wherein the frame of the noise-reduced speech signal has reduced noise relative to the frame of the noisy speech signal.

Claim 1 is not shown or suggested in the combination of cited art. In particular, none of the references show or suggest determining a scaling parameter for each frame of a harmonic component by determining the ratio of an energy of the harmonic component in the frame without the random component of the frame to an energy of the frame of the noisy speech signal. In addition, none of the cited references show or suggest determining a scaling parameter for a harmonic component that changes as the ratio of the energy of the harmonic component to the energy of the noisy speech signal changes while using a fixed scaling parameter for a random component, wherein the fixed scaling parameter is the same for all frames.

In the Office Action, Table III of Rezayee was cited as showing a harmonic scaling parameter that is a ratio of an energy of the harmonic component without the random component of the frame to an energy of the noisy speech signal. Applicants respectfully dispute this assertion.

First, in Table III of Rezayee, the computation of $g_i(n)$ is the computation of one of the diagonal elements of the gain matrix $G(n)$. In Table III, this gain matrix is applied against a signal $Y(n)$ which is defined as "input noisy speech vector $Y(n)$" (Rezayee, page 92, Section E., 1st paragraph). Thus, the gain calculated in Table III of Rezayee is not a harmonic scaling parameter because it is not multiplied by the harmonic component of a frame, as required by claim 1, but instead is multiplied by the noisy speech signal.

In addition, the computation of $g_i(n)$ does not show the ratio of an energy of a harmonic component in a frame without the random component of the frame to an energy of the frame of the noisy speech signal as required by claim 1. First, the energy of the noise in Rezayee is based on noise in previous frames and not on the same frame as the clean speech signal. On page 91, left column, first full paragraph, Rezayee discusses the determination of noise energy from a previous silence interval and an estimate of the noise energy from a previous frame. Rezayee recognizes that its computation of the noise energy does not accurately reflect the actual noise energy in the frame because when the computed noise energy is subtracted from the noisy speech

signal, "sometimes the answer of above subtraction becomes negative." Thus, in Rezayee, the noise computation is not based on the random component of the same frame as the noisy speech signal, but instead is based on noise from other frames.

As noted in the present Specification, relying on background noise from a previous frame creates errors and does not remove as much noise as may be desired. For example, if the environment is relatively quiet when no speech is present, background noise will be measured as being quite low. However, if the speaker begins to speak and at the same time the noise increases, the Rezayee system will not detect the noise increase and will continue to apply the old noise when determining the gain. The gain will therefor not reflect what is actually happening in the current frame. However, with the invention of claim 1, the scaling parameter will better track the actual ratio of the energy of the harmonic component within the current frame to the energy of the noisy speech signal within the current frame since it does not rely on a past noise level.

In addition, the combination of cited references does not show a scaling parameter for a harmonic component that is determined from a ratio of an energy of a harmonic component to the energy of a noisy speech signal used in combination with a fixed scaling parameter for a random component where the same fixed scaling parameter is used for all frames.

In the Office Action, it was asserted that Gao teaches a scaling parameter that is fixed in paragraphs 53 and 54. However, as noted by Gao, the scaling factor Gf is only fixed when "only background noise (no speech) is detected in the frame." Thus, for frames that have speech, the scaling factor produced by Gao would be different. As a result, the scaling factor in Gao is not the same for all frames as required by claim 1.

Applicants note that as written, claim 1 provides a step of multiplying the random component of a frame by a fixed scaling parameter for the random component for each frame of the noisy speech signal. Thus, although Gao shows a fixed scaling value for every frame that contains nothing but noise, it does not show a fixed scaling parameter that is the same for all frames of a noisy speech signal.

Further, those skilled in the art would not replace the scaling parameter in Gao with a scaling parameter that is fixed so that it is the same for all frames. Under Gao, the gain factor is

based on the noise-to-signal ratio. When the noise increases, the gain factor decreases causing a reduction in the signal that is sent between the encoder and decoder. When the noise decreases, the gain factor increases. If the gain factor where fixed for all frames, there would be no need for the gain factor. The purpose of the gain factor is to remove more noise by attenuating an unquantized long-term predictor gain and an unquantized fixed codebook gain when noise is present in the signal. If a fixed value is used, the same gain would be applied to noisy and noise-free signals. This would have the effect of simply reducing the energy of all signals whether they included speech or noise. Those skilled in the art would not perform such an action since it would make it more difficult to hear the speech signal without removing any noise from the speech signal.

Since the prior art does not show determining a scaling parameter for a harmonic component for a frame based on the energy of the harmonic component in the frame and the energy of the noisy speech signal in the frame or using a scaling parameter for a harmonic component that is determined for each frame while using a fixed scaling parameter for a random component for all frames, the combination of cited art does not show or suggest the invention of claim 1 or claims 2, 3, and 5-12, which depend therefrom.

CLAIMS 13, 15-17, 20, 24, AND 25

Independent claim 13 provides a computer-readable storage medium having computer-executable instructions for performing a series of steps. Those steps include identifying a harmonic component and a random component in a noisy speech signal, wherein identifying the harmonic component comprises modeling the harmonic component as a sum of harmonic sinusoids, each sinusoid having an amplitude parameter. A weighted sum is formed to produce a noise-reduced value representing a noise-reduced speech signal that has reduced noise compared to the noisy speech signal. The weighted sum is formed by multiplying the harmonic component by a scaling value for the harmonic component to form a scaled harmonic component, multiplying the random component by a scaling value for the random component to form a scaled random component, and adding the scaled harmonic component to the scaled random

component to form the noise reduced value. The scaling value for the harmonic component is different than the scaling value for the random component. In addition, the scaling value for the harmonic component is separately determined for each frame of the noisy speech signal and the scaling value for the random component is fixed for all frames of the noisy speech signal so that the same scaling parameter for the random component is used at each frame of the noisy speech signal.

Claim 13 is not shown or suggested in the combination of cited art. In particular, none of the cited references show or suggest a scaling value for a harmonic component that is separately determined for each frame of a noisy speech signal together with a scaling value for a random component that is fixed for all frames of the noisy speech signal.

In the Office Action, paragraphs 53 and 54 of Gao were cited as showing a scaling parameter for a random component that is the same for all frames of a noisy speech signal. As indicated above, Gao indicates that the scaling factor will only be the same for frames containing only noise. In other frames of a noisy speech signal, the scaling parameter will changed based on the noise-to-signal ratio. Thus, Gao does not show or suggest a scaling value for a random component that is fixed for all frames of a noisy speech signal.

Since the combination of cited art does not show or suggest the combination of a scaling value for a harmonic component that is separately determined for each frame of a noisy speech signal with a scaling value for a random component that is fixed for all frames of the noisy speech signal, the combination does not show or suggest the invention of claim 13 or claims 15-17, 20, 24, and 25, which depend therefrom.
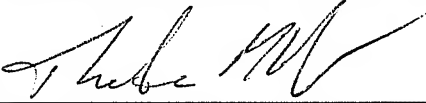
CONCLUSION

In light of the above remarks, claims 1-3, 5-13, 15-17, 20, 24, and 25 are in form for allowance. Reconsideration and allowance of the claims is respectfully requested.

The Director is authorized to charge any fee deficiency required by this paper or credit any overpayment to Deposit Account No. 23-1123.

Respectfully submitted,

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